

As our invention, we claim:

1. An apparatus for collecting yard debris comprising:

- a. a frame;
- b. a shredder blower unit mounted on said frame;
- c. a collector-rotor means mounted on said frame comprising impeller elements adapted to:
 - i. engage a surface, collect yard debris thereupon, and
 - ii. impel said yard debris toward said shredder blower unit;
- d. an air-solids separator means mounted on said frame operatively connected to said shredder blower unit for separating said yard debris into a debris-enriched stream and a debris-depleted stream by action of body forces thereupon; and
- e. an accumulation means adapted to receive said debris-enriched stream from said air-solids separator;

said collector rotor means being configured for substantially untrammelled engagement with yard debris having a depth of at least about two (2) inches.

2. An apparatus for collecting and reducing yard debris comprising:

- a. a frame adapted for movement in a principal direction upon a surface;
- b. a first duct mounted on said frame having an entrance and an exit;
- c. a collector rotor assembly comprising: a collector rotor body disposed at the entrance to said first duct having a substantially horizontal axis of rotation generally normal to said first direction; and a plurality of impeller elements

mounted upon said collector rotor body, said impeller elements being adapted to:

- i. sweep over said surface,
- ii. collect yard debris thereupon, and
- iii. impel said yard debris toward said duct entrance,

said impeller elements extending radially from said collector rotor body by at least about one quarter of an inch;

said collector rotor assembly and said first duct being configured for substantially untrammed frontal engagement with yard debris having a depth of at least about two (2) inches;

- d. a second duct mounted upon said frame having an entrance and an exit;
- e. a shredder blower unit, disposed between the exit to said first duct and the entrance to said second duct, adapted to:
 - i. provide suction at the entrance of said first duct;
 - ii. induce a flow of air through said first and second ducts; and
 - iii. reduce yard debris entrained in said flow of air as it passes through said shredder blower unit;
- f. an air-solids separator means disposed at the exit to said second duct for separating said reduced yard debris in said flow of air induced by said shredder blower into a debris-enriched stream and a debris-depleted stream;

- g. an accumulation means mounted on said frame adapted to receive said debris-enriched stream from said air-solids separator; and
 - h. means mounted on said frame adapted to provide power to said shredder blower unit and said collector rotor.
- 3. The apparatus of claim 2 wherein said impeller elements extend radially at least about an inch from said collector rotor body.
- 4. The apparatus of claim 2 wherein said collector rotor assembly comprises a substantially gas-impervious impediment to unrestricted flow of air into said first duct and extends substantially athwart said entrance to said first duct.
- 5. The apparatus of claim 2 wherein said collector rotor assembly comprises three impeller elements generally equispaced around said collector rotor body.
- 6. The apparatus of claim 4 wherein said collector rotor assembly further comprises fillet means extending between adjacent impeller elements for limiting carriage of yard debris around said collector rotor assembly, wherein said fillet means partially define generally concentric interrupted annular cavity spaces between adjacent impeller elements.
- 7. The apparatus of claim 2 further comprising a housing means for limiting the flow of air between said housing means and said collector rotor assembly without substantially impeding air flow along said surface under said collector rotor assembly and into said entrance of said first duct, said housing means:
 - a. being disposed above said collector rotor assembly,

- b. being an arcuate portion of a generally cylindrical shell spanning an upper portion of said collector rotor assembly concentric to said axis of rotation of said collector rotor body, and
 - c. engaging each of said impeller element tips in flow-limiting proximity seriatim.
- 8. The apparatus of claim 7 further comprising vertically extending seal means carried on said frame adjacent to the ends of said collector rotor assembly for limiting axial flow of air flow into said rotor assembly.
- 9. The apparatus of claim 7 further comprising vertically extending seal means carried on said ends of said collector rotor assembly for limiting axial flow of air flow into said rotor assembly.
- 10. The apparatus of claim 7 wherein said housing means defines a frontal opening extending from said surface vertically to a height of at least four inches and a suction opening under said rotor extending rearwardly from the front of said apparatus at least to a line below said axis of rotation of said collector rotor body.
- 11. The apparatus of claim 7 wherein said impeller elements mounted on said collector rotor body are configured to allow intermittent rearward rushes of air under the forward side of said rotating rotor body into said entrance to said first duct, and pulsed forward rushes of air under said first duct and into said first duct entrance, thereby alternately collecting principally bulky yard debris from said forward side of said rotor body during said rearward rushes of air and enhancing collection of residual debris from said surface during said pulsed forward rushes of air.

12. The apparatus of claim 7 further comprising an air-slot means defined within said housing means between the upper lip of said housing means and said entrance to said first duct for allowing flow of air in a direction opposed to the direction of rotation of said collector rotor body and into said first duct and stripping leaves and debris from said rotating rotor assembly.
13. The apparatus of claim 2 wherein said entrance to said first duct generally spans the length of said collector rotor body and said first duct converges rearwardly such that the convergence angle throughout the duct is generally less than 100 degrees.
14. The apparatus of claim 2 wherein said air-solids separator means comprises:
- a. a first passage for accepting said flow of air bearing entrained reduced yard debris from said second duct;
 - b. a separation chamber adapted to receive said flow of air from said first passage;
 - c. a second passage adapted to exhaust said debris-depleted stream from said separation chamber into the atmosphere; and
 - d. a baffle means for:
 - i. generally inhibiting secondary flow from said accumulation means; and
 - ii. impeding re-entrainment of fine particulates in said debris-depleted stream as it is discharged to the atmosphere;said baffle being disposed to permit passage of entrained reduced yard debris into said accumulation means while impeding passage of fine particulates of reduced yard debris in air exhausted from said separation chamber through said second passage.

15. An apparatus for collecting yard debris comprising:

- a. a frame adapted for movement in a principal direction upon a surface;
- b. a duct mounted on said frame having an entrance and an exit;
- c. a collector rotor assembly comprising: a substantially impervious collector rotor body disposed and extending substantially athwart said entrance to said duct and having a substantially horizontal axis of rotation generally normal to said first direction; and a plurality of impeller elements mounted upon said collector rotor body, said impeller elements being adapted to:

- i. sweep over said surface,
- ii. collect yard debris thereupon, and
- iii. impel said yard debris into said duct entrance;

said impeller elements:

- i. extending radially from said collector rotor body by at least about one quarter of an inch; and
- ii. having approximately equal radial extension from the axis of rotation of said collector rotor assembly;

- d. a housing means disposed adjacent said entrance to said duct for limiting the flow of air between said housing means and said collector rotor assembly without substantially impeding air flow along said surface under said collector rotor assembly and into said entrance of said duct, said housing means:

- i. being disposed above said collector rotor assembly;

- ii. engaging each of said impeller element tips in flow-limiting proximity seriatim; and
 - iii. being configured to permit substantially untrammed frontal engagement of said collector rotor assembly with yard debris having a depth of at least about two (2) inches;
 - e. an air-movement means being connected to said exit of said duct and adapted to:
 - i. provide suction at the entrance of said duct, and
 - ii. induce a flow of air through said duct; and
 - f. a means mounted upon said frame adapted to provide power to said air-movement means and said collector rotor.
16. The apparatus of claim 15 further comprising vertically extending seal means carried on said frame adjacent to the ends of said collector rotor assembly for limiting axial flow of air into said rotor assembly.
17. The apparatus of claim 15 wherein said housing means defines a frontal opening extending from said surface vertically to a height of at least four inches and a suction opening under said rotor extending rearwardly from the front of said apparatus at least to a line below said axis of rotation of said collector rotor body.
18. The apparatus of claim 15 wherein substantially gas impervious impellers mounted on said collector rotor body are configured to allow intermittent rearward rushes of air under the forward side of said rotating rotor body into said entrance to said first duct, and pulsed forward rushes of air under said first duct and into said duct entrance,

thereby alternately collecting principally bulky yard debris from said forward side of said rotor body during said rearward rushes of air and enhancing collection of residual debris from said surface during said pulsed forward rushes of air.

19. The apparatus of claim 15 wherein the tips of said impellers further comprise pliable blades being yieldable to hard objects encountered on said surface, but being sufficiently stiff to sweep debris from undulating said surface.
20. The apparatus of claim 15 wherein said tips of said impellers comprise rows of radially-extending raker teeth adapted to engage and impel debris objects on said surface toward said duct entrance.
21. The apparatus of claim 15 wherein said housing means
 - a. comprises an arcuate portion of a generally cylindrical shell spanning an upper portion of said collector rotor assembly generally concentric to said axis of rotation of said collector rotor body, and
 - b. is disposed in flow-limiting proximity to at least one tip of one of said impeller elements during at least about one fourth of the time of revolution of said collector rotor assembly.
22. The apparatus of claim 21 further comprising an air-slot means defined within said housing means between the upper lip of said housing means and said entrance to said duct for allowing flow of air in a direction opposed to the direction of rotation of said collector rotor body into said duct for stripping leaves and debris from rotating said collector rotor assembly.

23. The apparatus of claim 15 wherein said entrance to said duct generally spans the length of said collector rotor body and said duct converges rearwardly such that the convergence angle throughout the duct is generally less than 100 degrees.
24. The apparatus of claim 15 wherein the cross-sectional area of the channel through said duct measured normal to the center flow line of said airflow through said duct remains generally constant along said center flow line.
25. The apparatus of claim 15 further comprising a lawnmower mounted on said frame wherein said collector rotor assembly and said entrance of said duct are disposed along the advancing front of said lawnmower.
26. The apparatus of claim 25 wherein said collector rotor assembly impels said yard debris into the mowing chamber within the mowing enclosure of said lawnmower.
27. A free-flow apparatus for separating entrained lawn debris from a transporting air stream by action of body forces thereupon comprising:
- a. a means for delivering a stream of air bearing entrained lawn debris;
 - b. means defining a primary-separation duct having an entrance and exit, said entrance being adapted to receive said stream of air bearing entrained lawn debris, said duct being adapted for conducting said stream of air bearing entrained lawn debris from said entrance to said exit; said primary-separation duct having a generally curvilinear outer surface spanning an arc of at least about
 $\arccos(RI/RO)$
circumferentially along its length, adapted to direct said stream of air bearing

entrained lawn debris to flow generally circumferentially along its length and initiate separation of said stream of air bearing entrained lawn debris into an outerly located debris-enriched stream and an innerly located debris-depleted stream, wherein

RI = radius of curvature for the generally curvilinear inner surface of said primary-separation duct, and

RO = radius of curvature for said generally curvilinear outer surface;

- c. means defining a secondary-separation chamber connected to said exit from said primary-separation duct and having a generally annular outer wall defining a primary axis generally co-incident with the center of curvature of said generally annular outer wall, said secondary-separation chamber further comprising means for
 - i. receiving and directing said streams of air bearing entrained lawn debris from said primary-separation duct in a direction generally tangential to said generally annular outer wall of said secondary-separation chamber,
 - ii. directing said outerly located debris-enhanced stream from said primary-separation duct adjacent to said outer wall of said secondary-separation chamber,
 - iii. directing said innerly located debris-depleted stream from said primary-separation duct radially inward of said debris-enriched stream, and

- iv. further separating said streams of air bearing entrained lawn debris into an upwardly and inwardly directed debris-depleted stream and a downwardly and outwardly directed debris-enriched stream;
- d. means defining a generally centrally located passage having an entrance and an exit, said generally centrally located passage being adapted for:
 - i. receiving said upwardly and inwardly directed debris-depleted stream from said secondary-separation chamber through said entrance, and
 - ii. conducting said upwardly and inwardly directed debris-depleted stream to said exit and discharging it into the atmosphere;
- e. a baffle extending generally outwardly from a central point below said entrance to said passage, the outer periphery of said baffle being spaced inwardly from said generally annular outer wall; and
- f. means providing an opening around said baffle into the interior of an accumulation chamber below said baffle;

said baffle being disposed to permit passage of entrained yard debris in said downwardly and outwardly directed debris-enriched stream into said accumulation chamber while impeding passage of fine particulates of reduced yard debris from said accumulation chamber into air discharged from said separation chamber through said passage.

28. The apparatus of claim 27 wherein the plane of said periphery of said baffle is disposed below the uppermost portion of said primary-separation duct by a distance of less than 1.2 times the inside diameter of said secondary-separation chamber having a

generally annular outer wall, with said inside diameter of said secondary-separation chamber being measured in said plane of said periphery of said baffle.

29. The apparatus of claim 27 wherein the plane of said periphery of said baffle is disposed below the lowermost portion of said entrance to said passage by a distance of less than 0.6 times the inside diameter of said secondary-separation chamber having generally annular outer wall, with said inside diameter of said secondary-separation chamber being measured in said plane of said periphery of said baffle.
30. The apparatus of claim 27 wherein said baffle further comprises an upright cone having its apex pointing toward said entrance of said second passage.
31. The apparatus of claim 27 wherein the radial distance from said baffle periphery to said outer wall of said separation chamber is less than about one fourth of the inside diameter of said separation chamber, measured in approximately the same plane as said plane of said periphery of said baffle.
32. The apparatus of claim 27 wherein said accumulation chamber further comprises a flexible bag-like container.
33. The apparatus of claim 27 wherein said means for delivering a stream of air bearing entrained lawn debris further comprises a lawnmower having a discharge duct connected to said entrance of said first passage.
34. A free-flow apparatus for separating entrained lawn debris from a transporting air stream by action of body forces thereupon comprising:
 - a. a means for delivering a stream of air bearing entrained lawn debris;
 - b. a separation chamber having an upper bulkhead and an outer wall;

- c. a first passage having an entrance and exit, said entrance being adapted to receive said stream of air bearing entrained lawn debris, said passage being adapted for conducting said stream of air bearing entrained lawn debris from said entrance to said separation chamber, and adapted to direct said stream of air bearing entrained lawn debris into said separation chamber in a direction primarily tangential to said outer wall of said separation chamber, wherein said separation chamber being adapted to separate said stream of air bearing entrained lawn debris into an outerly located debris-enriched stream and an innerly located debris-depleted stream;
- d. a generally centrally located second passage having an entrance and an exit, said generally centrally located second passage being adapted for:
 - i. receiving said innerly located debris-depleted stream from said separation chamber through said entrance, and
 - ii. conducting said innerly located debris-depleted stream to said exit and discharging it into the atmosphere;
- e. a baffle extending generally outwardly from a central point below said entrance to said second passage;
- f. the outer periphery of said baffle being spaced inwardly from said outer wall;
- g. means providing an opening around said baffle into the interior of an accumulation chamber below said baffle, said baffle being disposed to permit passage of said innerly located debris-depleted stream into said second passage while impeding passage of fine particulates of reduced yard debris from said

accumulation chamber into said air discharged from said separation chamber through said second passage;

wherein the overall height of said apparatus from the uppermost portion of said apparatus to the plane of said outer periphery of said baffle being less than about 1.2 times the inside diameter of said separation chamber proximate said baffle periphery.

35. The apparatus of claim 34 wherein said first passage is curvilinear in a plane generally perpendicular to the axis of said outer wall and has its concave surface generally concentric about said axis of said outer wall.
36. The apparatus of claim 34 wherein the plane of said periphery of said baffle is disposed below the lowermost portion of said upper bulkhead by a distance of less than about 0.6 times the inside diameter of said separation chamber.
37. The apparatus of claim 34 wherein said first passage extends declivously from said entrance toward said exit and directs said stream of air bearing entrained lawn debris into said separation chamber.
38. The apparatus of claim 34 wherein
 - a. said first passage is curvilinear in a plane generally perpendicular to the axis of said generally cylindrical outer wall section,
 - b. the outer wall of said curvilinear passage is disposed approximately coincident with said outer wall section of said separation chamber, and

- c. said outer wall section of said separation chamber is disposed at least about three inches radially outward from the perimeter of said entrance to said second passage.

39. The apparatus of claim 38 wherein said outer wall section of said separation chamber is disposed at least about five inches outwardly from the perimeter of said entrance to said second passage.